Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

NOTES ON THE THEORIES OF ORIGIN OF GYPSUM DEPOSITS.

By R. S. SHERWIN, University of Oklahoma, Norman, Okla.

Read before the Academy, at Iola, December 30, 1901.

SEVERAL different theories have been given to account for the origin of gypsum beds, but the one which is most generally accepted for the formation of the gypsum of Kansas and Oklahoma is that of evaporation of water in an inland sea. When sea-water is evaporated gypsum is deposited, and if the evaporation is continued a heavier deposit of salt is obtained.

The substance of the argument in favor of this theory is that the gypsum is often more or less closely associated with salt, and that the composition in many cases is similar to that of the material obtained by evaporation of sea-water.

Some idea of the amount of water which must have been evaporated during later Permian times in Kansas and Oklahoma, according to this theory, can be obtained by calculations based on the composition of sea-water. It is improbable that sea-water ever contained a larger percentage of gypsum than it does at present; so the estimates of the amounts of water are not likely to be too high.

According to the most reliable analyses,[1] sea-water contains 3.5 per cent. of mineral matter, of which 3.6 per cent. is calcium sulphate. Ordinary rock gypsum contains about 21 per cent. of water of crystallization, as expressed by the formula $CaSO_4 + 2H_2O$. Taking this into account, the amount of gypsum contained in sea-water is about 0.16 per cent. The specific gravity is given[2] at from 2.28 to 2.31. Using the lower figures, the thickness of the layer of pure rock gypsum which could be deposited from a body of water one foot in depth is a little less than .0007 foot. It is stated that the process must have been continuous in Kansas while at least eight or nine feet of rock gyysum was being formed. Taking the lower estimate, the amount of water which must have been concentrated during the period of continuous deposits of gypsum was the equivalent of a sea or lake more than 11,000 feet deep, and covering the area over which the deposits were made.

As it is unlikely that an inland sea with a depth of two miles was cut off and evaporated sufficiently to deposit all of its gypsum, some hypothesis must be brought forward to show how this enormous amount of water could have been supplied. It is possible to conceive of a large basin, shallow except in the area where the deposit was formed, and to suppose that as the water was concentrated it retired into the deeper part, and that the salt already deposited was washed down with it.

---

[1] Challenger Reports, Encycl. Britt., article "SEA."

[2] Univ. Geol. Surv. of Kan., vol. V, pp. 22, 80.

Or the water might have been supplied by flowing in over a bar at a rate about equal to that of evaporation. Some water must have been furnished by the streams which carried in the clay that is found in irregular layers in the gypsum, but, unless there was some source of gypsum aside from sea-water, these streams would add very little to the amount of gypsum, and they would increase the amount of water to be evaporated.

In whatever manner we suppose the water to have been supplied, the real difficulty in the way of the evaporation theory is that of accounting for the concentration of such enormous amounts of water within a comparatively short time. The depth of two miles given above for the inland sea is for a layer of rock gypsum only eight feet thick; and as the total thickness in many places is at least four or five times as much, besides an unknown amount taken away by erosion, the water evaporated during later Permian times cannot have been much less than the equivalent of a sea eight or ten miles deep over the area where the heavy deposits of gypsum are, or where they have been removed by erosion.

In order to produce the necessary concentration, the surface of the gypsum sea must have been subjected to a dry climate; but the presence of mud and sand is evidence that the neighboring land was not so arid as the hypothesis seems to require. There is very little evidence that an inland sea of any great size existed in that place in Permian times. The hypothesis of an inland sea seems to have very little foundation except the hypothetical evaporation of water for the formation of gypsum and salt beds. There is no great unconformity such as must have resulted if the land to the west had been extensive enough to produce the necessary climatic conditions. "The Colorado plateau was a sea bottom continuously, or nearly so, from the beginning of the Carboniferous to the end of the Cretaceous."[3] If an inland sea of any great extent had existed in Kansas, Oklahoma and Texas during Permian times, and had been surrounded by a sufficient area of land to produce such evaporation, there would be a general absence of Permian rocks in the mountains west of the gypsum area.

If we accept the evaporation theory, the existence of different layers of gypsum alternating with other rocks requires us to suppose that the crust movements were extremely complex. We must suppose that inland seas were formed many times in succession in the

---

3. Le Conte, "Earth Crust Movements and their Causes," Smithsonian Report, 1896, p. 239.

same place and then drained at the right time to deposit most of their gypsum and little of their salt. It is true that the gypsum area contains some salt, which is so soluble that it is difficult to imagine any way other than evaporation in which it could have been laid down, but the salt beds do not require the supposition of such a series of concentrations on a vast scale. Sea-water contains seventeen times as much sodium chloride as calcium sulphate, and the thickness of the salt beds is almost insignificant in comparison with the gypsum.

Taking all these things into consideration, it seems that a small part of the gypsum closely associated with the salt may have been deposited by evaporation, but there must have been some other source for the massive rock gypsum.

A saturated solution of calcium sulphate and a saturated solution of sodium chloride do not give any precipitate when they are mixed; so the gypsum could not have been precipitated by the salt in the ocean.

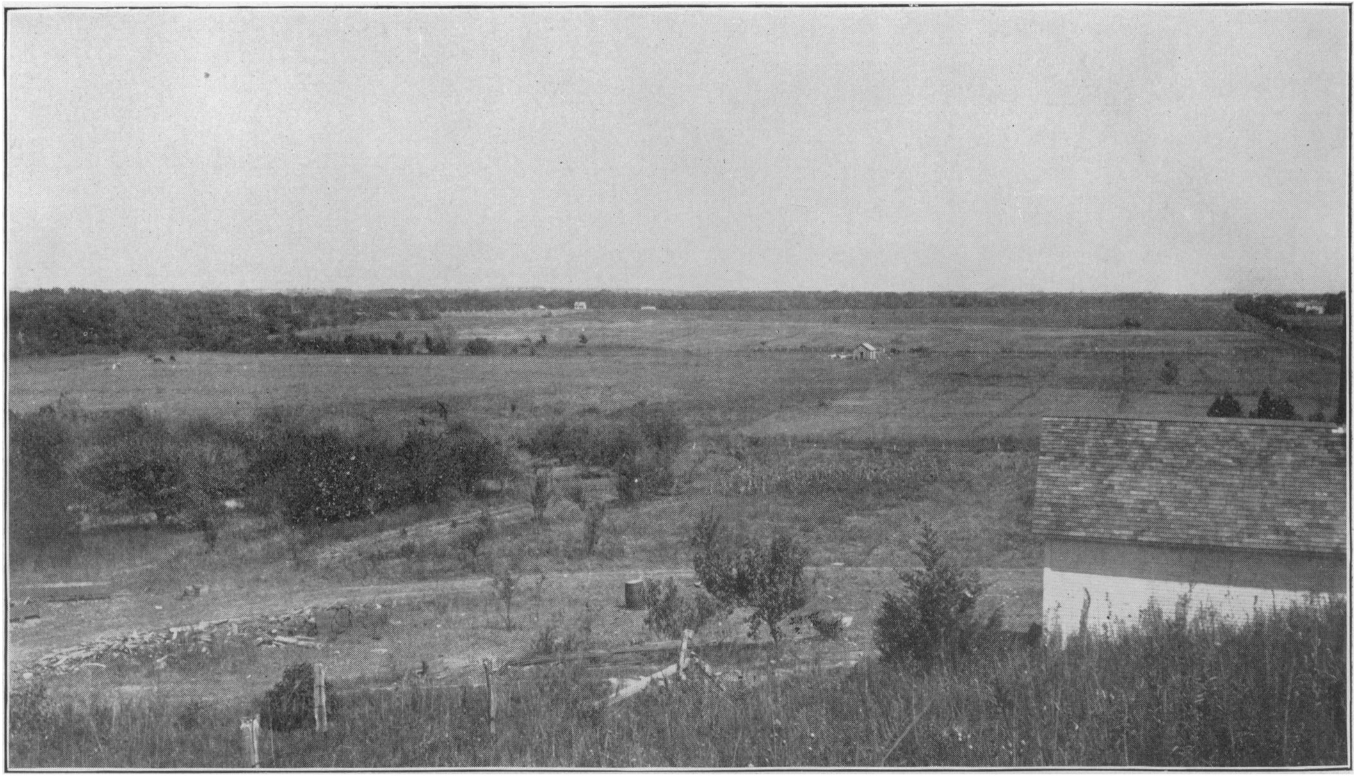
Large amounts of limestone have been removed from the land east of the gypsum beds. This erosion was going on in Permian times, and the lime must have been redeposited somewhere. The most natural place to look for it would be on the western coast or marginal sea bottom of that time. It is possible that the whole of the Red Beds underlying the gypsum was formed at or near the advancing shore line. This would account for the ripple-marks and for the presence of so much sand, either alone or mixed with clay and other material.

One of the properties of sulphides, especially of the alkalies and alkaline earths, is the readiness with which they take up oxygen and form sulphates. Springs containing soluble sulphides are not very common, but there is at least one in Indian Territory,[4] and it is probable that there are others in some parts of the plains. There may have been more such springs in earlier times, or there may have been sulphur gases in contact with some strata. The Permian age is supposed to have been one of disturbance and crust movements, and therefore there may have been more sulphides and sulphur gases in the springs or in contact with the strata below the surface than there are now. If any sulphide existed, either in springs or in the soil which was being eroded, a part of it would have been oxidized to a sulphate and carried away by streams along with the limestone and other material. The limestone, whether in solution or not, would be changed to a sulphate and deposited as a sediment of gypsum at the seacoast.

The gypsum would follow the general laws of sediments, and the amount would depend on the amount of sulphides or sulphates and on the character of the strata being eroded. Hence there might be all gradations from gypsiferous shales to pure gypsum. At some time the limestone might not have been changed to gypsum and beds of limestone, dolomite or calciferous sandstone would be formed, mixed or interstratified with clay.

---

[4] Sulphur Springs, Chickasaw Nation, I. T.



Field south of Iola, in 1898, where the Iola Portland Cement Mill was erected in 1899 and 1900.